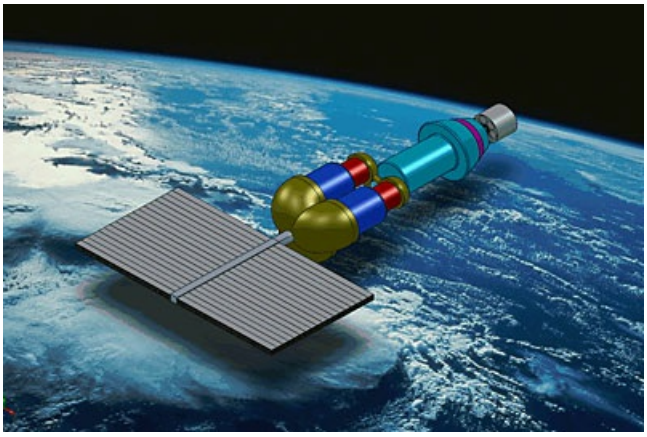
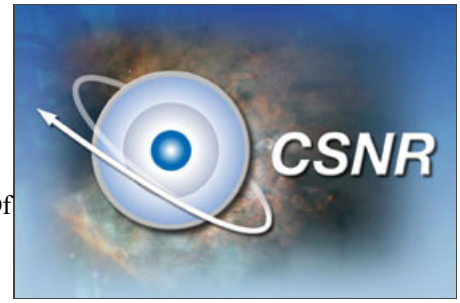


Idaho National Laboratory's Center for Space Nuclear Research (CSNR) offers an intense Summer Fellows program where graduate and undergraduate students tackle questions surrounding space exploration and nuclear spacecraft propulsion.

Students design new ways to explore our solar system

By Brianna McNall, *INL Nuclear Science & Technology intern*

The mysteries of the night sky have always been a source of fascination. Students from 17 universities around the United States spent their summer vacations designing new ways to explore those mysteries.



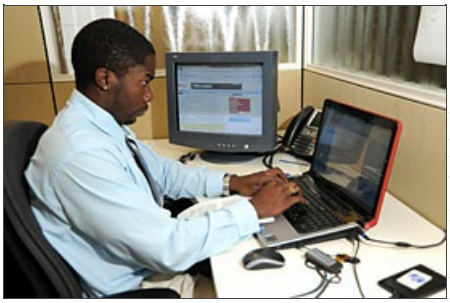
Of 158 students who applied for the CSNR summer 2010 fellowships, only 18 were selected.

Idaho National Laboratory's Center for Space Nuclear Research (CSNR) offers an intense 10-week CSNR Summer Fellows program for graduate and undergraduate students in nuclear engineering, physics, mechanical engineering, aerospace engineering, mathematics and chemistry. Of the 158 students who applied for the summer 2010 fellowships, only 18 were selected.

Students spend the first several weeks in a crash-course about nuclear technology and its applications for space exploration. They are assigned to teams based on their education and research interests, and given one of several main topics to explore. This year's topics were: new "hopper" designs for the moons Titan and Europa, concepts for advanced nuclear reactor designs with reduced weight that would be useful for space propulsion, the design of low steady-state or pulsed-power systems for lunar surface or low Earth orbit operation, and a design for a Mars Sample Return mission craft that would bring physical samples back from the Martian surface.

The students are allowed to switch topics once they start, but not many do. Graduate student Jarred Reneau from Mississippi State University stayed on his assigned project because it was a good fit.

"I chose to remain on this team because it involved electrical propulsion and my master's study is in electrical propulsion," he said.



This year's research topics included advanced nuclear reactor designs for space propulsion and a design for a Mars Sample Return mission craft.

Reneau's team was asked to design a nuclear power source for space exploration, with electric generation levels of 20MWe and 10kWe, respectively. They had the extra challenge of reducing the size of the power source to less than half the mass per kWe of previous systems. The group came up with two designs, both small nuclear reactors with similar "heat-pipe" coolant structures. They had to be very creative to think of design materials that would be sturdy and heat-resistant, but would also have a very low density. Both designs were impressive, but a short summer internship made it difficult to cover all of the issues, such as feasibility of reactor startup.

Another group of interns worked on finding a concept that would allow an unmanned Mars mission to collect samples on the surface and bring them back to Earth. The interns tried two methods — a mission fueled by a radioisotope generator and a mission fueled by a nuclear reactor.

The radioisotope method didn't work out too well, but the nuclear reactor method involved an orbiting "mother ship" and a small lander, which would jettison sample canisters into orbit. These would be collected by the orbiting craft and returned to Earth.

The third group developed a design for a hopper craft on Europa, one of Jupiter's moons that is entirely covered in ice. Because of its highly eccentric orbit, Europa is subject to strong tidal forces from Jupiter that pull, distort and crack its icy surface. This makes the moon's surface extremely unsettled and rough. Scientists believe Europa has an ocean underneath its icy cover, and there is the possibility that life could exist around geothermal vents like those found in Earth's oceans. Because of this, exploration of this moon is particularly interesting, especially around these very difficult cracks, where the seawater from underneath might well up to the surface. The rover-type vehicles used to explore the Martian surface until now would have no way of navigating this terrain. A hopper, able to leap several kilometers vertically as well as horizontally, would have much more mobility.

The last group worked on a design to provide low-, 10kWe pulsed power for lunar surface operation or low-Earth orbit, where steady power

production may not be necessary. They created a radioisotope-powered system that collects power and then discharges it in a burst once it's reached a certain level.

This year's projects were more focused on planetary and surface exploration capabilities. With the push to further explore Mars, the importance of nuclear power is growing.

"Nuclear power is enabling – a lovely NASA term that means you cannot do it any other way," said Steven Howe, CSNR director.

Most of the students started their fellowships with a fairly limited idea of what nuclear power was and how it could be utilized for space applications. Ten weeks later they left, having tackled some of the most intriguing and difficult questions plaguing the proponents of space exploration and nuclear spacecraft propulsion.

CSNR Fellows were given access to several cutting-edge facilities, including the computer-assisted visualization environment (CAVE) that allows computer simulations to be seen in three dimensions. Students also had opportunities to draft and submit papers for publication and practice their speaking skills in weekly updates given to their colleagues in the program.

Fellows get access to cutting-edge facilities, opportunities to submit papers for publication and public speaking practice during weekly updates for colleagues.

One of the CSNR Fellows, Regal Ferulli, had worked as a science intern before.

"I got a lot more hands-on experience here," he said.

At the CSNR Fellows final presentations, Howe introduced the student presenters and said the summer program had given them all an in-depth understanding of nuclear and radioisotope power and heating systems for space applications. The students presented in groups, and their presentations included simulations and even one cast model. Howe closed out the presentations with praise for the students.

"This has been a very productive summer," he said. "The students have proven some ideas and disproven some. They are a tremendous group of folks."

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